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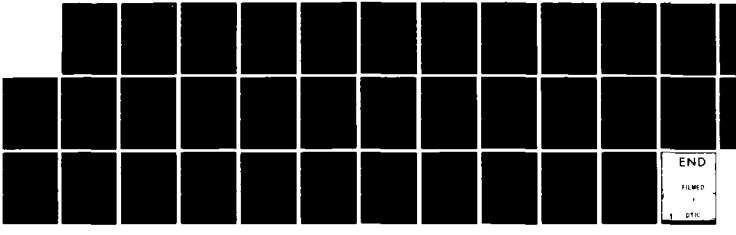

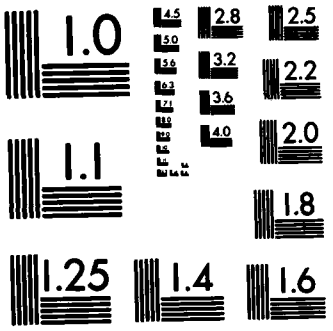

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This paper deals with the career progression of mid-life engineers and with the variety of meanings that engineering has for people in that occupation. It is based on questionnaire data from 90 engineers at two points of time (first in 1970, age 30's to early 40's; second in 1978-9, all over 40) and on detailed interviews with 12 of them. The results show that changes in reactions to work are systematically associated with the degree to which the 1978-9 job differs from the 1970 one. The relations are complex and related to the personal meaning that engineering has for the respondents.

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Engineering as a Life-Long Career: Its Meaning, Its Satisfactions, Its Difficulties

by

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Sloan School of Management
Massachusetts Institute of Technology

October, 1982

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An earlier version of this paper was presented in a symposium on Career Development of Technical Professionals at the annual meeting of the Academy of Management, August 13, 1980, Detroit, Michigan. The research on which it is based was supported in part by the Office of Naval Research under contract N00014-80-C-0905; NR 170-911. The authors are grateful to the respondents who gave so generously of their time. They wish to thank, also, Professors Dalton, Kopelman, Nelson, Schein, and Van Maanen for helpful comments on the earlier version.

Engineering as a Life-Long Career: Its Meaning, Its Satisfactions, Its Difficulties

> Remainder of professional life is currently very unlikely to change as the result of current assignment. ... Net result is far less intensity of expectation.
>
> Professionally my career is stagnant and going nowhere. The industry employment outlook has improved to the point where I may be able to find another job. However, whether I can get a decent position after 12 nonpromoted years is questionable. I think my abilities are well suited for my present career, but I've not been given credit (promotions) except money.
>
> Frustrated. The job bores me to death. ... I am seriously considering early retirement and pursuit of a new career. I do not feel I am ready to retire but I need challenge in my work and will not be given that opportunity by my employer, due to my age bracket.

So speak engineers over forty: bored, stagnant. Some, of course, have escaped this fate: "Am working on more complex problems requiring more technical knowledge, and generally speaking this work is more satisfying." But even challenging assignments involve career risks for engineers: "Being somewhat creative along technical lines, my assignments were usually in high-risk new developments. When these were not as successful as hoped for, my career would come to a standstill and I would literally have to start over again."

Management is seemingly the only route to success:

> I am very enthusiastic about my professional life. Previously I felt somewhat hemmed in and denied the opportunity to move into management and demonstrate my competence. My opportunity to do so came 8 years ago and since that time I have had very worthwhile and satisfying experiences. At this point in my career further opportunities appear to be materializing.

But for some engineers this route is a mixed blessing. As one engineering manager reports, professionally he is now "not as happy" as he was before his promotion: "Never had ambitions towards management. Enjoyed technical work very much. Now I am sad all the way to the bank."

Engineering, as a career, is full of contradictions. Because it is characteristically played out in large organizations, it shares with all organizational careers the fact that hierarchical movement (the cultural definition of success in that setting) is systematically unavailable to all but a few of an organization's employees (Brown, 1981). But it carries the added dilemma, identified already by Hughes, that to be successful in engineering means to leave it:

> The engineer who, at 40, can still use a slide rule or logarithmic table, and make a true drawing, is a failure (Hughes, 1958, p.137).

Nor is engineering, even though it is based on technical expertise, a profession (Kerr et al., 1977). It is subject to organizational rather than occupational control (Child and Fulk, 1982), and practitioners have been shown, as a group, to subscribe more to organizational than to professional values (Ritti, 1971; Bailyn, 1980). But the formal education of engineers seems to prepare them for professional work. The resulting "reality shock" led one 37-year old engineer to complain bitterly that engineering schools should "present a realistic picture of what engineering is like 'on the job'. Most of us are 'intellectual prostitutes', drones to companies that hire and fire; we're not really professionals."

Engineering is also not an occupational community (Van Maanen and Barley, forthcoming), a collegial form of work association in which members "claim a distinctive and valued social identity, share a common perspective toward the mission and practices of the occupation, and take part in a sort of interactive fellowship that transcends the workplace." In fact, the meaning of engineering as a career seems to be more personally than socially defined, and the occupational self-definition of "engineer" does not necessarily correspond to a person's work activities.[1]

It is an occupation, then, that fits many stereotypic molds (Bailyn, 1982), and when one moves inside these stereotypes, one finds a much greater variety than is commonly assumed. It is this variety, and the particular forms that it takes, that is the subject of this paper. The data are based on questionnaires from 90 "engineers" at two points in their careers (one in their thirties and early to mid forties and another 8½ years later when they were all over 40 and some were in their fifties)[2] and on intensive interviews with twelve of them.

Kerr et al. (1977) have noted the many definitions (or lack of definition) of "engineer" that researchers have used. Generally these have been based either on education or on current work activities. We chose to use both criteria. Further, because of the vagaries of the engineering career already referred to, we selected a group who fitted these criteria well into their careers. It is not a representative group, therefore, of engineering graduates. But it is a very homogeneous group, at least as based on these externally defined characteristics. The variety of internal, personal meanings given to engineering by these respondents is therefore particularly significant.

Our analysis will proceed from the outside to the inside. First, we outline what happened to this group of engineers between 1970 and 1978-9 in terms of the external characteristics of their jobs. How stagnant are engineering careers in these middle years? What movement, if any, takes place? Second, we relate this movement (or lack of movement) to changes in the reactions of these engineers to their work and to their careers. Are they now more or less involved with their work? And what about their satisfaction with their jobs and their perceptions of success: have these changed? Such relationships between external movement and changes in internal reactions give a deeper sense of the satisfactions and difficulties associated with this career. Finally, we probe into the inner meaning of engineering in the lives of these respondents.

To do so, we turn to the intensive interviews with twelve of them.

External Career Paths

The target population for the 1978-9 follow-up were 158 MIT graduates from the 1950's who had responded to a career survey in 1970[3] and at that time were staff engineers, that is, engaged primarily in actual technical work. All had bachelor's or master's degrees in engineering, but we eliminated any with a doctorate or MBA at that time, as well as any who had not started their careers as engineers in industry.[4] Ninety of these also filled in extensive questionnaires in 1978-9. They comprise the sample for this paper; details are given in Table 1.

Nearly three-quarters of this group were still staff engineers in 1978-9, divided into those who were in identical jobs; those whose technical assignments had changed but whose level of responsibility for coordination or supervision had remained the same, and those who had increased their coordinating or supervisory responsibilities, but whose primary function was still technical work and thus they would still be classified as staff engineers. Most of those who had left staff engineering positions were now engineering managers (at least two levels beyond the working engineer), though some had left engineering altogether and had shifted to non-technical staff or management functions and a handful of other occupational positions.[5]

Based on this comparison of job titles and brief description of function we can divide the sample into five groups of increasing change of the 1978-9 occupation from the engineering staff job held in 1970:

		N	%
1.	identical job	15	17
2.	change in technical assignment	26	29
3.	still a staff engineer, but increased coordination/supervision responsibility	20	22
4.	engineering manager	15	17
5.	no longer on engineering career path	14	15
		90	100

By design, every person in this sample was a staff engineer in 1970. Hence each was already well set on a particular career path at that time, and the subsequent 8½ years brought only minor changes. Indeed, it is really only the last of these five categories of change that indicates a clear branching from the engineering path.[6] And even here, we discovered in the interviews, the external change is not always equally great when viewed from the person's own perspective.

Nor was there much movement to other companies. By definition, the first group are still working in their 1970 organizations. But so are almost three fourths (73%) of the second group and two-thirds of the third (65%) and fourth (67%). And even among those who have left the engineering career path (group 5), over one third (36%) are still with the same organization.

This group of maturing engineers, therefore, is relatively stable. Looked at externally, one does not see much movement.[7] And yet, these five categories do seem to represent differences in how these engineers perceive the nature of their work to have changed. When asked themselves to compare their current work to what they were doing in 1970, a clear pattern emerges, as is evident in Table 2.

Those in identical jobs (first column) report the smallest change in the nature of their work, though even here there is some variation. In particular almost half of these people indicate an increase in "mentoring" activities, in the extent to which they spend time "consulting with, advising, informally instructing, or guiding colleagues." And yet they do not show as much increase in this as the second group, who have changed technical assignments. And of those who have increased coordinating or supervisory responsibilities (including those now in clearly managerial positions), almost all report more mentoring activities. These groups have also shifted their responsibilities to broader, more complex projects.

If we exclude the group who have left the standard engineering career path (who are now primarily in non-technical areas), it is obvious from the respondents' own descriptions that these categories of occupational movement represent increasing change away from specialized technical projects, towards more complex responsibilities within their organizations. Moreover, this change is accompanied by a perception of increased recognition from both inside and outside the organization, and by greater career satisfaction.

Changes in the externally defined career paths of this group of mature engineers during this 8½ year period are slight when compared to the full range of technical occupations. Looked at from the outside, these careers are fairly stagnant, especially those in the first three groups. It is of particular interest, therefore, whether the difference among these groups in the reported changes in the nature of the work is related to a corresponding difference in how that work is reacted to.

Changes in Reactions to Work

Movement and change have been assumed to be important for the careers of maturing engineers (Bailyn, 1982). Our data confirm this point. In particular, they show that the amount of movement away from the 1970 job is significantly related to changes in these respondents' involvement with their work. Group 1 decreased its work involvement during this 8½ year period; Groups 4 and 5 increased it; and Groups 2 and 3 stayed essentially the same, with Group 2 showing a slight negative and Group 3 a slight positive change.[8] The data are shown in Table 3.

The index of work involvement was empirically derived from responses of the total 1970 sample (see Bailyn, 1980, Appendix D). That analysis identified a cluster of interrelated items dealing with the extent to which work is the major aspect of a person's life, more important than leisure and other non-work related activities, and even of more central concern than one's family. It is

possible, therefore, to define two sub-components of work involvement, one dealing directly with work (e.g. "my main satisfactions in life come from the work I do") and the other dealing with the importance of family (e.g. importance of "job which leaves sufficient time for family and personal life"). Data on these components of work involvement, also presented in Table 3, show that it is the changes in orientation to family, rather than to work, that differentiate these groups. Group 1 shows a significant increase in family orientation; Group 4 a significant decrease. Neither shows much change in work orientation. In fact, only Group 5, who have left the engineering career path altogether, show a sizeable increase in work orientation as well as a decrease in family orientation.

Thus we see that movement away from the 1970 job is accompanied by an increase in work involvement, which is more dependent on changes in orientation to family than it is on changes in orientation to work. In particular, those in identical jobs for this period of their lives significantly increase their orientation towards their families, whereas those who have been promoted to management significantly decrease their family orientation.

Three factors, shown in Table 4, help explain this relationship. The first is the movement to a new organization. It turns out that respondents who stayed in their original organization increase their family orientation, those who moved to a new organization decrease it. Second, those with short job tenure, whose job changes occurred within 3 years, increase their work involvement (decrease their family orientation), whereas those in jobs for more than 3 years decrease their involvement with work (increasing family orientation). Finally, chronological age, though not itself significantly related to changes in work involvement, nonetheless aids our understanding of these findings. The relevant data are presented in Table 5.[9]

As far as Group 1 is concerned, we can only look at age (Table 5c), since by definition they are in the same organization and have not had a recent job change. We see a difference by age in all three measures. Younger respondents in identical jobs decrease their work involvement to a greater extent than do older ones, and increase their family orientation more. They also are more likely to decrease their work orientation, whereas the older respondents in this group are more likely to increase it. The biggest change among the engineers in identical jobs occurs in the younger group. The change in family orientation, in fact, is so great that the younger respondents in identical jobs are more family oriented in 1978-9 than their older counterparts, which is quite contrary to the overall trend for family orientation to increase with age. These findings support the contention that the period around 40 is critical in the engineering career. If one passes this point without having had a job change for some time, the response is likely to be a reorientation away from work and towards one's family.[10]

When one turns to Group 2, those staff engineers who have had a new technical assignment during this period, one finds, generally, little change in reactions, which fits the picture already drawn of this group. Group 3, in contrast, though also still staff engineers, are less homogeneous. In particular, job tenure (Table 5b) - the length of time in the coordinating/supervisory job - makes a difference in the work involvement and family orientation of this group. If the job is relatively new, then work involvement increases as family orientation goes down. But after more than 3 years in the job the reverse effect is noticeable: family orientation now increases.

It seems almost as if the stimulating effect of adding coordinating/supervisory responsibilities is short-lived. There is evidence of this also from Group 4, who have actually been promoted to be engineering managers. Here, too, the decrease in family orientation noted for this group is not evidenced by those few whose job tenure exceeds 3 years, who show, in fact, the opposite trend.

For engineering managers, also, moving to a new organization (Table 5a) accentuates the tendency to decrease family orientation.[11] In other words, it seems not to be the addition of managerial responsibilities per se that is associated with a decrease in family orientation, but, rather, the effect seems to be dependent on the signal value of this change, which is accentuated by its recency or its occurrence in a new setting.

Finally, in Group 5 - among those who have left the engineering career path - we find the largest differences. Since the group includes a number of people who have made substantial career shifts, this is not surprising. In fact, it is only those of this group who have moved to a new organization whose reactions have changed. They are now more involved with their work: less family oriented and more work oriented. Further, these changes are evident only if the move occurred relatively early.[12] Whether shifts out of engineering among older respondents are less voluntary is not known. *In any* case, this finding provides further supporting evidence for a critical age point in the engineering career. People who opt to shift out during this period become considerably more involved with their work. And, contrary to the case of promotion to engineering manager (Group 4), this change in reaction seems to be accentuated among those few people who have lived with the new job for more than 3 years. Perhaps, therefore, it indicates an intrinsic response to the new work activities.

To summarize so far, we have seen that the more movement there is from the 1970 job, the more involved these engineers become with their work, primarily because their family orientation decreases. For those who add managerial duties to their engineering jobs, this change is most evident during the first few years of the new job, and is accentuated if the new job is also in a different organization. We have seen evidence, also, for a critical point in the engineering career around the age of 40. Staying in an identical job for any length of time at about this age is very likely to lead to a reorientation away from work and

towards family, which does not seem to happen if the ng job tenure occurs at a later age. Similarly, moving away from the engineering career path altogether produces a change towards work and away from family only if it happens during these same critical years. Thereafter, no such change in reaction is evident.

Thus we see that change in the external career paths of these engineers is indeed related to change in their reactions to their work. It is interesting, therefore, that it is not accompanied by any significant change in job satisfaction or in perceived success. Engineering managers (Group 4) increase their job satisfaction slightly (+.47) and respondents leaving the engineering career path altogether (Group 5) perceive themselves as somewhat more successful (+.42). But there is no corresponding decrease in either job satisfaction or perceived success for those who stay in identical jobs. Indeed, it seems as if this group evaluate their careers equally as successful and satisfactory in 1978-9 as they did in 1970, but that the internal definition on the basis of which this judgment is made has changed. Only Group 2, those engineers with new technical assignments whose reactions to work we saw to be the most stable, show a decrease in their level of perceived success (-.38). They also have significantly decreased their success aspirations, the extent to which they value success at work and have high aspirations for their careers (-92*). (It is only Group 5 who show any increase in success aspirations (+.57).)

In 1978-9, as is evident in Table 6, it is Groups 1 and 4 who are most satisfied with their jobs. Group 1 also perceive themselves as fairly successful, but generally feel that they have reached the height of their careers. Groups 4 and 5, in contrast, though not as successful in their own eyes at the present time, are expecting still to become more successful. Respondents in Group 5, moreover, who feel that they have reached their career heights, are least likely of any group to be disappointed with their career success. It is Group 2 who evaluate their careers most negatively: little perceived success now and, among those who have reached their career heights, a majority perceive themselves as fairly unsuccessful.[13]

It looks, then, as if remaining in an identical job through a critical mid-life period in the engineering career, leads engineers to reevaluate the role of work in their lives. They tend to turn away from career and orient themselves more towards family, but they remain satisfied with their jobs and still feel successful. A change in technical assignment during this period seemingly precludes this reevaluation and may result, rather, in diminished feelings of success. Adding coordinating/supervisory duties during this career period seems to have a stimulating effect for a short period of time. And if such additional responsibilities are accompanied by a promotion to engineering manager, then one sees a definite increase in work involvement and lessened family orientation. Moreover, such engineering managers are quite satisfied with their jobs and, even though their promotions came late in their careers, they still expect further career improvement. Finally, those engineers who leave the engineering career path during this period, particularly if they do so relatively early, are most likely to reorient towards work, and most optimistic about their career success.

These differences, based as they are on questionnaire responses, represent no more than modal group tendencies. Though they are suggestive, they do not allow us to understand the individualized meaning of what has happened to these people, as is evident from the comments of three engineers, all of whom stayed in identical jobs throughout this 8½ year period. The first, at 56, is now very satisfied with his job, though in 1970 he had been quite dissatisfied. It is a satisfaction that stems from coming to terms with the limits of his situation, a process that resulted in a decrease in his work involvement:

> I'm satisfied. I know my limitations and live accordingly. I'd like to do better, but then I don't put in a maximum effort; so - you get out of life what you put into it. I've enjoyed it, so far.

Another engineer, now 45, is also satisfied with his job. But so he was in 1970, and his work involvement has not changed: it is low now and was low then. Then as now, he is much more oriented to family than to work and yet his perceived success

is high. He has only one complaint:

> No demands are put on me on the job. I am left alone to fill my time as I please except for occasional consultations. In this situation laziness takes over. I have a job with good pay, no responsibility and little work. The only problem I have is boredom.

The final example is a 47-year old engineer who is not very satisfied with his job and does not perceive himself successful. Between 1970 and 1978-9 he dramatically increased his orientation to family and, looking back over his life, he would make the following change:

> Develop stronger family relationships. I feel these are slighted in response to the pressures of schooling, occupation, and community service. And yet they are the only thing that are inherently yours.

It is such individual interpretations of and reactions to career events that underlie the results so far presented. To see more clearly what lies behind our statistical associations we turn to the interviews, the goal of which was to see what engineering meant to these respondents.

Personal Meaning of Engineering

The interview subjects were chosen from among those of the ninety questionnaire respondents who had indicated their willingness to be interviewed, who lived on the East coast (to keep phone costs down), who represented all of the occupational groups identified in the 1978-9 questionnaire, and who could be reached by telephone on the nights of the interviewing - a quasi-stratified-random procedure. The interviews were all done by one of us, a male engineer from MIT, who could easily talk with these men about the details of their work. Each interview lasted about one hour. Respondents were called at their homes in the evening and with their permission the conversation was recorded.[14] Questions concerned what they did on their current jobs on a day-to-day basis, and then concentrated on what we called an intellectual history of their activities since entering MIT as freshmen.

Table 7, which gives the characteristics of this sample as based on their questionnaire responses, corroborates a number of the findings already presented.

But it shows, also, the variation within each group. It seems, therefore, that the same external career path is responded to in different ways, depending on the meaning of that career to the individual involved. From the interviews we were able to get a sense of these personal meanings. In a separate report we present the individual cases in sufficient depth to give a picture of the total lives of these engineers (Lynch, forthcoming). Our current aim is only to present the dimensions of meaning that have emerged from our analysis and to illustrate them by means of the interview data.[15]

One of the first things we noticed was that a number of these respondents - even those in positions classified as staff engineering - were actually not engaged in "real" engineering activities: in analyzing, designing, fabricating, or testing some physical device or process that was to serve some specific function. Rather, they were performing a number of peripheral activities - peripheral, that is, to the type of engineering activities that an MIT graduate would probably expect to perform. An example is an operations and maintenance engineer who is responsible for scheduling the use and repair of machines in a large chemical plant, or a federal agency R&D administrator who coordinates development projects (with a budget exceeding tens of millions of dollars) in a very specialized area. This is an important point: people who consider themselves and are considered engineers may vary widely in the type of work they actually do. But we were trying to identify more subjective differences. In particular, we were interested whether engineering activities (defined, as above, from an external "MIT" point of view) are the activities that "turn the engineer on" - that "give him his kicks". And though there is a high correlation between this internal and external definition of "real" engineering, they do not necessarily go together. Thus, a process design engineer, centrally involved in a highly specialized engineering area, nonetheless values equally the non-engineering parts of his job - travel, contractor selection, and supervision - and looks ahead with pleasure to a time when he can take over his boss's job, which is administrative and only peripherally technical.

An early clue from the interviews of whether respondents were highly involved with engineering activities per se came from the way they talked about their work. Some were immediately able to describe their activities and could indicate clearly what they particularly liked about them. Others talked about these activities, present and past, almost as if they were contentless. The extreme of this was the engineering manager who remembers all the names of his colleagues and supervisors, and even of his professors of more than twenty years before, and yet is hard put to describe the content of his courses or to be specific about the actual activities of his job.

An interesting point is that those engineers for whom the actual engineering activities are highly meaningful can usually trace this interest to childhood, and revert to it during their careers even if they have been diverted by circumstance. For these respondents engineering is more than an entry into a career; it is its essence.

In some ways, of course, this distinction is applicable to all occupations. It is not only in engineering that there are differences in the extent to which the actual work involved in an occupation is meaningful to the person pursuing it. What is more interesting, and more specific to engineering itself, is the character of these valued engineering activities. Pursuit of this question led us to a dimension we refer to as concrete puzzle orientation. What is important to engineers high on this dimension is the gratification that comes from building things, taking things apart, and figuring things out; the pleasure derived from working with something concrete, a product one can see, and which provides one with almost immediate feedback on how one is doing. The prototype is the crossword puzzle, hence the name.

Three of our twelve engineers had this orientation very strongly. Two of these are high technology specialists, they like what they do, and look forward to doing it for a long time. The third, surprisingly, is strong on this orientation even though he is not very involved with the actual engineering activities of his

job. The meaning of this dimension is somewhat different for him, as will be seen.

The first engineer, in digital communications, describes it in the following way:

> Supposedly the computer calculates everything, but the result you get doesn't work so you have to go back and modify and play the game of debugging. In my digital equipment game I actually enjoy the debugging more than the design. It's like trying to solve a puzzle. There is something exciting in that. There is something eluding you and you try every single path and then examine those paths which give you success, it's more of an investigative kind of thing. It is a mystery story. Every trouble shooting is a mystery story.

And, like a mystery story, it has a clear solution. It is important to note, further, that the "game" this engineer is referring to is quite different from a zero sum game where there must be a loser for every winner and, in a corporate hierarchy, where there must be many losers. This is not so in the concrete puzzle "game", where a person with sufficient skill and diligence can be assured of winning. In this "game" you are not out to beat another person or team but to reach some difficult but clearly achievable goal in a relatively limited amount of time.

The second engineer's concrete puzzle orientation emerged most clearly in the following spontaneous closing remark:

> Let me throw one thing in that might tie together something, and that is the eternal tinkerer approach. Nothing can escape me. If it's mechanical and it doesn't work I've got to fix it no matter what it is and as a result I have a house full of garbage which should have been taken out long ago, but I have to take it apart first. I like the challenge of making something work.

In fact, he pursues such pursuits at home as well as on the job:

> To some degree I do more of that at home, having a car in five thousand pieces. But that seems to have varied according to what my job was. When I hit times like the staff engineering job where I dind't feel I was being creative or really getting anything done, then at that time I tended to work a little harder at the little things going on around the house just in order to feel that you were still able to whip these problems whether or not you can do it at work.

What is striking about this statement is the strong need of this aero systems analyst to solve such puzzles. If he doesn't get enough of it at work, he compensates by doing more at home. His emphasis on still being able "to whip these problems" suggests a strong involvement in continual and concrete verification of self-worth.

The connection between concrete puzzle orientation and proving one's self-worth is even more apparent in the third engineer, the aero section head, who does not share with these first two the same involvement with engineering activities per se. In fact, he really feels now that he should have gone into a different field altogether. Nonetheless, he is very much aware that one of the "advantages in engineering is that you can see the product of your efforts, something tangible that you were responsible for, some concrete contribution that can make you feel proud of yourself." And, of particular interest, he continues by translating this directly into a measure of self-worth:

> In engineering you are quickly calibrated or evaluated. You can measure the efficiency of a product and this gives you an evaluation of your own success or failure. ... In some professions you never know whether you succeed or fail. You can convince yourself, but you never have solid proof whether you have done well. That's the advantage of hard core engineering. You know you can't fool yourself very long.

Thus, the meaning of engineering for those who are high on this dimension resides in the involvement with and gratification derived from solving technical puzzles. There are three critical aspects to such puzzles: they are known to have a solution; the procedures for attaining the solution are clear; and there is fairly immediate feedback on whether one is on the right track. In some ways, the engineer as concrete puzzle solver fits the popular stereotype of engineering. It is of interest, therefore, that only three of the 12 engineers in the interview sample are clearly high on this dimension, and three (the R&D administrator as well as the two who have left the engineering career path) show mo such proclivities at all.

A number of these respondents, therefore, derive no meaning from the actual activities they are engaged in. In this group belong those who have found

satisfactory careers by shifting way from technical and towards administrative and managerial activities, as well as those who have withdrawn from their work, whose lives now center on non-occupational activities, and who view their jobs purely instrumentally. A few, however, do derive meaning from their role as engineers but it centers more on defining for them who they are than on providing satisfactory activities for them to do. For them, being an engineer has symbolic meaning. It seems, further, that such an occurrence happens relatively late in one's career - almost as if it were necessary first to see whether technical or administrative activities were available that could be satisfactory.

The case in our sample from which this dimension emerged is an R&D administrator in his mid fifties. He describes his early career as a series of moves away from companies where there was "a long and winding road to get to the top" and where "looking at the future prospects it didn't look to me that I would zip up pretty far." Not being high on the dimension of concrete puzzle orientation, he spent some time looking for the best managerial route. And, in 1970, he classified himself as an engineering manager, even though his role was a combination of technical advising and R&D administration. By 1978-9, however, although his administrative responsibilities had actually increased somewhat, he identified his profession as engineering, and is clearly proud of being an MIT engineer. In the interim, it seems as if he has accepted the fact that he will not become as high a level administrator as he had once hoped to be. But instead of seeing himself as a medium level administrator, he falls back on engineering in its symbolic meaning, and now sees himself as a high level technical advisor associated with MIT. The critical issue here is that his job has not significantly changed but his image of who he is has. Furthermore, he vigorously pursues activities that further this self-image, by associating himself with MIT through dealing with prospective students and through fund-raising. Being an engineer is important to this respondent - and he is capable, works hard, and makes valuable

contributions - but it is important in a different way than it is to those whose involvement centers on the actual activities of engineering.

The other person high on this symbolic dimension highlights the fact that engineering may be used symbolically even when the activities it represents are themselves gratifying. This respondent, a chief engineer in a small company, is totally involved in his particular branch of engineering. The technical activities themselves are meaningful, and engineering, in some ways, defines the life of his whole family. Further, he has found a way of successfully combining a broad and far-reaching position with real involvement with daily technical activities. His solution, unique in this sample, stems from the fact that he works in an organization of less than 20 people and works in a field where projects are much smaller than those found in the aerospace or electronics industry. Thus he is able to function both as an engineering specialist and as a chief scientist who oversees the total operation of the company, and he uses his judgment to resolve important problems for his organization and its clients. It is a highly satisfactory integration for this man: "I love it. I think I have one of the best jobs I know of."

The experience of this engineer alerted us to the critical dimension of time scale and scope. The notion of <u>time scale</u> in the engineering career has already been alluded to in the presentation of the concrete puzzle orientation, for which quick feedback (i.e., a short time scale in one's activities) is an important ingredient. In fact, for people high on this orientation, it is this short time scale that mainly produces the "fun" of engineering, and provides, for some engineers, a critical link to self-esteem. The <u>scope</u> of one's activities refers to the extent to which one's work is focused on highly specialized, narrow issues or encompasses a wider range of concerns.

These two are often (though not necessarily) related. In particular, it is unlikely for wide scope and short time scale to be associated. In fact, a short

time frame (which may be highly beneficial for a continuous self-assessment of technical competence) does not usually permit the expression of what might be called engineering wisdom. Such wisdom usually evolves from years of experience and is often only afforded significant expression through long-term issues of relatively wide scope (cf., Thompson and Dalton, 1976).

Our observations on time scale and scope, thus, indicate a potential dilemma in satisfying all aspects involved. The chief engineer already mentioned is an example of someone who has come to a highly satisfactory resolution of this issue. But that depended on his being in a specific technical area and in a very small company. For most engineers there is no satisfactory way to combine a day-to-day involvement with technical engineering problems with an increased span of responsibility and concern. Faced with this dilemma, some engineers opt for scope, by turning to management, but then deprive themselves of the unambiguous and immediate gratifications obtainable from solving concrete technical problems. Others choose the exact opposite route and define for themselves a well-specified usually narrow area of technical expertise over which they have fairly complete control. But the autonomy thus attained characteristically precludes involvement with the larger issues of the organization, or even of a division or section. This dilemma represents a real challenge for the management of technical personnel. Any organization that has a number of engineers for whom both of these dimensions are meaningful, must address this issue. Perhaps the only way to design specific work assignments and rewards to meet these two different criteria is sequentially. But this will still be more effective than depending on career paths that respond only to one or the other of these dimensions, but not to both.

These, then, are the dimensions that have emerged from the interviews: concrete puzzle orientation, the symbolic meaning of engineering, and time scale and scope. We have seen, also, that the first and last of these may represent

important aspects of the engineering career that are not easily combined, given current organizational procedures. In fact, attaching symbolic meaning to being an engineer may, on occasion, substitute for finding a satisfactory mix of activities. The single case in our sample where all of this came together probably represents an example of a part of engineering that is a true occupational community (Van Maanen and Barley, forthcoming). But it is not the typical pattern.

Conclusion

What, then, can one say about engineering as a life-long career? The most general answer we can give is that there is no one answer. The engineers we have studied are very different from narrow stereotypes and from each other. Their careers do not necessarily fit the organizational stereotype of only one successful route: a shift from engineering to management. Nor does the meaning of engineering always match the popular stereotype of the eternal tinkerer and concrete puzzle solver. Indeed, less than half of our interview respondents seem to fit either of these two stereotypes.

It is our contention, rather, that to understand (and manage) an engineering life, it is necessary both to look more closely at career paths and to be aware of differences in the personal meaning of the occupation. For instance, our initial analysis indicated that engineers in identical jobs, though satisfied with them, seem to have re-evaluated the criteria by which they judge their careers. Then, from the interviews, we discovered that one of the three "identical" respondents re-evaluated his career around the symbolic meaning of engineering, whereas the other two have largely shifted their energies (and certainly their passions) to projects unrelated to their careers: one to a house, the other to a garden. It seems unlikely that one could determine the most effective way to manage these employees without the understanding gained by looking at their careers from both of these perspectives.

Perhaps the main conclusion to be drawn from our study is that a successful engineering career takes many forms. And since external opportunities are reacted to

and understood in different ways, it is unlikely that any set of specific recommendations will be applicable to all technical employees in all settings, or even in any one setting. In some ways, this point is itself the most important implication of our findings. Engineering can be a satisfactory life-long career if organizations can find ways to accommodate the many different shapes it is likely to take.

TABLE 1

1978-9 Follow-Up Sample

	N	
Graduates of School of Engineering	878	(65% of 1970 sample)
Who did not get their Doctorate or MBA by 1970	619	(70% of engineering graduates)
Whose first jobs were in engineering in private industry	374 [a]	(67% of non-Ph.D. non-MBA engineering graduates with information on first jobs)

Who in 1970 were in:

General Management	84	(22%)
Technical Management	87	(23%)
Staff Positions	158	(43%)
Non-engineering	45	(12%)

→ 1978-9 Follow-Up Population

Deceased or unreachable	7	[b]
No response	51	[b]
Partial (unusable) response	10	
Full response	90	

↓ 1978-9 Sample

Still staff engineers	61	(68%) [c]	No longer staff engineers	29	(32%)
identical job	15	(17%)	engineering manager	15	(17%)
change in technical assignment	26	(29%)	business staff	5	(6%)
change in coordination/ supervision	20	(22%)	non-technical functional manager	4	(4%)
			consultant	2	(2%)
			other	3	(3%)

→ 1 science staff (with a 1975 Ph.D.)
1 general manager
1 rural grocer

a 58 respondents did not give information about first jobs.

b 11 of these were reached by phone and asked to give their present occupation.

c Analysis of the 11 phone "respondents" indicates a predictable response bias (cf. Shuttleworth, 1940). All but one of these are still staff engineers and 9 of them are in identical jobs to what they had in 1970. Thus the table no doubt underestimates the actual percentage still in engineering staff positions, which is probably in the 71% (% including all non-respondents with known occupations) to 77% (% if all non-respondents are staff engineers in the same proportion as the phone sample) range.

TABLE 2

Respondent Comparison of 1978-9 Job to 1970 Job

	Engineering Staff				
	Identical (N=15)[a]	Change in Technical Assignment (N=26)[a]	Increased Coordination/Supervision (N=20)[a]	Engineering Manager (N=15)[a]	Non-Engineering (N=14)[a]
Technical area of work:					
same	100%	46%	100%	71%	14%
different	0	46%	0	21%	21%
non-technical	0	8%	0	7%	64%
Technical depth and breadth:					
same or more narrow and specialized	58%	54%	30%	0	0
broader, more general	33%	38%	60%	57%	36%
no longer technical	8%	8%	10%	43%	64%
Project responsibilities:					
same or smaller	75%	38%	25%	7%	21%
larger, more complex	25%	38%	65%	64%	29%
no longer responsible for individual projects	0	23%	10%	29%	50%
More responsibility for professional personnel	0	19%	55%	73%	14%
More mentoring activities	42%	65%	80%	100%	62%
More recognition from professionals outside organization	25%	16%	47%	64%	33%
More recognition from within organization	25%	48%	50%	86%	85%
More job and career satisfaction	17%	54%	55%	71%	64%

[a] These Ns are reduced where necessary by non-response to particular questions.

TABLE 3

Changes in Work Involvement

	Engineering Staff			Engineering Manager	Non-Engineering
	Identical (N=15)[a]	Change in Technical Assignment (N=26)[a]	Increased Coordination/Supervision (N=20)[a]	(N=15)[a]	(N=14)[a]
Change in Index of Work Invovement[b]	-.45*	-.10	+.09	+.25	+.34
Change in Family Orientation[c]	+1.14*	+.35	0	-.64*	-.46
Change in Work Orientation[d]	+.07	+.10	+.09	+.14	+.46

* Statistically significant change for that group (α=.05).

[a] These Ns are reduced where necessary by No Answers to relevant items.

[b] The index of work involvement is an average composite of 7 items and ranges from 1 (low) to 5 (high). Its exact derivation is available in Bailyn, 1980, Appendix D. A one-way analysis of variance on these change scores for the 5 groups shows a significant difference between groups (eta=.323). The contrast between Group 1 and Group 4 is statistically significant.

[c] The measure of family orientation is a composite of 3 of the items used in the index of work involvement. It gauges the importance of family relative to work and career and has a range from 0 (low) to 6 (high). Its scores were reversed (and somewhat amended) when used in the index of work involvement. A one-way analysis of variance on these change scores shows a significant difference between groups (eta=.355). There are significant contrasts between Groups 1 and 4, and also between the combination of Groups 2 and 3 with both Group 1 and with Group 4.

[d] Work orientation is based on the other 4 items in the index of work involvement. They stem from a work alienation scale (Rapoport and Lohman, n.d.) which has 5 response categories per item. The measure is averaged to range from 1 (low) to 5 (high). Analysis of variance shows no significant difference between groups (eta=.154).

TABLE 4

Other Factors Affecting Changes in Work Involvement

	Changes in Work Involvement	Changes in Family Orientation	Changes in Work Orientation
Change in Organization			
same (N=62)[a]	-.08	+.37)	+.20
new (N=28)	+.18	-.42) *	+.05
Job Tenure			
short (N=49)	+.18)	-.37)	+.15
over 3 years (N=41)	-.22) *	+.73) *	+.16
Age			
early 40s (N=42)	+.05	+.18	+.34
late 40s (N=25)	0	0	+.08
50s (N=23)	-.10	+.14	-.09
late 40s and 50s (N=48)[b]	-.05	+.07	0

* Statistically significant difference (α=.05).

[a] These Ns are reduced where necessary by those who did not answer relevant items.

[b] Because of small Ns, these groups are combined in subsequent analysis.

TABLE 5a

Relation of Change in Organization to Changes in Work Involvement

	change in:	Same Organization	New Organization
1. Identical job	work involvement	-.45	---
	family involvement	+1.14	---
	work orientation	+.07	---
		(N=15)[a]	(N=0)
2. New Technical Assignment	work involvement	-.09	-.13
	family orientation	+.42	+.14
	work orientation	+.21	-.21
		(N=19)	(N=7)
3. Increased Coordination/Supervision	work involvement	+.12	+.04
	family orientation	+.11	-.14
	work orientation	+.23	-.18
		(N=13)	(N=7)
4. Engineering Manager	work involvement	+.24	+.25
	family orientation	-.40	-1.25
	work orientation	+.39	-.30
		(N=10)	(N=5)
5. Non-Engineering	work involvement	+.02	+.54
	family orientation	0	-.75
	work orientation	+.15	+.64
		(N=5)	(N=9)

[a] These Ns are reduced, where necessary, by No Answers to relevant items.

TABLE 5b

Relation of Job Tenure to Changes in Work Involvement

	change in:	New Job (0-3 years)	In Job > 3 years
1. Identical Job	work involvement	---	-.45
	family orientation	---	+1.14
	work orientation	---	+.07
		(N=0)	(N=15)[a]
2. New Technical Assignment	work involvement	-.14	-.05
	family orientation	+.31	+.40
	work orientation	0	+.25
		(N=16)	(N=10)
3. Increased Coordination/Supervision	work involvement	+.48	-.30
	family orientation	-1.00	+1.00
	work orientation	+.05	+.12
		(N=10)	(N=10)
4. Engineering Manager	work involvement	+.33	-.03
	family orientation	-.91	+.33
	work orientation	+.12	+.19
		(N=11)	(N=4)
5. Non-Engineering	work involvement	+.33	+.55
	family orientation	-.36	-1.00
	work orientation	+.44	+.62
		(N=12)	(N=2)

[a] These Ns are reduced, where necessary, by No Answers to relevant items.

TABLE 5c

Relation of Age to Changes in Work Involvement

	change in:	Early 40s	Late 40s and 50s
1. Identical Job	work involvement	-.86	-.22
	family orientation	+2.20	+.56
	work orientation	-.33	+.33
		(N=6)[a]	(N=9)
2. New Technical Assignment	work involvement	-.11	-.10
	family orientation	+.54	+.15
	work orientation	+.33	-.13
		(N=13)	(N=13)
3. Increased Coordination/Supervision	work involvement	+.27	-.05
	family orientation	-.14	+.11
	work orientation	+.28	-.07
		(N=9)	(N=11)
4. Engineering Manager	work involvement	+.20	+.29
	family orientation	-.71	-.57
	work orientation	0	+.25
		(N=7)	(N=8)
5. Non-Engineering	work involvement	+.66	-.03
	family orientation	-.71	-.17
	work orientation	+1.29	-.36
		(N=7)	(N=7)

[a] These Ns are reduced, where necessary, by No Answers to relevant items.

TABLE 6

Job Satisfaction and Perceived Success in 1978-9

	Engineering Staff				
	Identical (N=15)[a]	Change in Technical Assignment (N=26)[a]	Increased Coordination/Supervision (N=20)[a]	Engineering Manager (N=15)[a]	Non-Engineering (N=14)[a]
% very satisfied with their 1978-9 jobs[b]	40%	20%	15%	40%	21%
% who see themselves as very successful in 1978-9[c]	27%	4%	20%	7%	14%
% expecting still higher success (after 1978-9)[d]	13%	27%	20%	33%	38%
% of those now at height of career who perceive themselves as NOT successful[e]	38% (N=13)	53% (N=19)	31% (N=16)	30% (N=10)	12% (N=8)

[a] These Ns are reduced, where necessary, by No Answers to relevant items.

[b] Respond 5 ("very satisfied") to question "How satisfied are you with your present job?" with response categories ranging from 1 ("very dissatisfied") to 5.

[c] Respond 5 ("very successful") to the question "At this point in your professional life, how successful do you think you are in your work?" with response categories ranging from 1 ("unsuccessful") to 5.

[d] Respond a higher degree of expected success to the question "How successful do you think you will be at the height of your career?" than to the question on success at this point (see note c).

[e] 1978-9 success rated as $\leq$ 3, of those who do not expect to be more successful at the height of their career than they are now.

TABLE 7

Interview Sample

(based on questionnaire responses)

	Age	Years in Job	New Organization	change in: work involvement	change in: family orientation	change in: work orientation	present assessment: job satisfaction	present assessment: success
Staff Engineers								
in identical jobs:								
1. R&D Administrator	56	23	-	-	+	0	high	medium
2. Mechanical Support	40	9	-	--	++	0	medium	medium
3. Process Engineer	52	16	-	+	0	++	high	high
with new technical assignment:								
4. Operations & Maintenance	45	6	no	+	0	+	high	low
5. Aero Systems Analyst	40	3	no	0	0	0	medium	medium
6. Digital Communications	41	4	no	0	0	+	high	high
with increased coordination/supervision								
7. Aero Section Head	41	2	no	NA	NA	+	low	low*
Engineering Managers								
8. Engineering Manager	45	5	yes	NA	NA	0	low	low*
9. Division Director	47	2	no	0	0	0	high	medium
10. Chief Engineer	41	2	yes	+	--	0	high	medium*
Non-Engineering								
11. Rural Grocer	45	2	yes	0	0	+	high	low*
12. Marketing Manager	53	0	no	0	0	0	high	medium

* respondent expects success at height of career to be higher

Legend: NA - no answer to 1 or more items
++ - increased substantially
+ - increased
0 - essentially no change
- - decreased
-- - decreased substantially

Notes

1. Nearly one third (24 of 90) of a group of people identified as working in engineering jobs did not include the word "engineer" in their replies to a question asking them what they consider their profession to be. And almost half (11 of 28) of a group who were no longer doing engineering staff work nonetheless still identified their profession as "engineer."

2. This is a period during which engineering performance has usually been found to decline, a decline associated with declining expectancies and values (Kopelman, 1977) and with inadequate movement along the four stages of the technical career (Thompson and Dalton, 1976).

3. Questionnaires for this survey were sent to the more than 2,000 graduates of the MIT classes of 1951, 1955, and 1959. The final sample used here is based on the 1351 male respondents, representing a response rate of more than 60%. The 15 (out of 22) female graduates who responded to the survey were not included. Analysis of the total 1970 data is available in Bailyn, 1980.

4. Previous analysis of the 1970 data from this selected sample is available in Bailyn, 1977. This group represents only 12% of the total number of male MIT graduates who responded to the survey.

5. Ages in the total group range from 40 to 59. Just under half were in their early forties, about a quarter in their late forties, and another quarter in their fifties. Those in identical jobs tended to be somewhat older and those who moved into management were somewhat younger: 33% of the former were in their fifties compared to only 13% of the latter. Those in identical jobs reported an average tenure of 14 years in their current jobs, compared to averages of between 2 and 4 years for the other groups.

6. It is of interest to note that of the 13 people who earned a degree between 1970 and 1978-9, none is still in an identical job and 5 have left the engineering career path altogether.

7. Applying Hall's (1980) scheme for gauging occupational change in older employees (which goes from 0 to a maximum of 23), we find that 60% of this sample are at 3 or less.

8. It turns out that the average lack of change in Group 3 hides a fair amount of individual change: people originally high who decreased their involvement and those initially low who increased it. This highlights the fact that engineers respond in very different ways to the addition of supervisory/coordinating duties to their jobs. It contrasts with Group 2, where the overall lack of change reflects also individual stability in work involvement.

9. Since these classifications reduce the Ns considerably, we can no longer depend on statistical significance tests to assess our results. Rather, we use as our guide the magnitudes found significant in Tables 3 and 4. In particular, we assume that a group will only have changed significantly if it exceeds the following amounts (based on Table 3):

change in work involvement	$> \|.45\|$
change in family orientation	$> \|.65\|$
change in work orientation	$> \|.50\|$

In a similar fashion (based on Table 4), we assume that the following differences within any one group will have to be exceeded for significance:

for work involvement	D > .4
for family orientation	D > .8
for work orientation	D > .5

10. If one disaggregates the older respondents in this group into those in their late 40s and those in their 50s, one gets the impression that eventually an adaptation occurs (cf. McKinnon, 1982). Respondents in their 50s, who were well into their 40s already in 1970, show no change in family orientation and even seem to increase their work orientation:

change in:	late 40s	50s
work involvement	-.65	+.12
family orientation	+1.25	0
work orientation	+.06	+.55
	(N=4)	(N=5)

11. Moving to a new organization also has a differential effect on the work orientation of respondents in this group: it tends to decrease, rather than increase it. This is hard to explain, but the effect is repeated in the other groups (Groups 2 and 3) where movement to a new organization nonetheless keeps the person on the engineering career path. It is only in Group 5 that moving to a new organization increases work orientation. And here the new organization is likely to represent a completely different kind of setting.

12. Disaggregation of the older respondents in this group emphasizes the point:

change in:	late 40s	50s
work involvement	+.10	-.17
family orientation	-.33	0
work orientation	+.08	-.69
	(N=3)	(N=3)

13. It is of interest, also, that this group has the lowest undergraduate grade point average (Group 5 has the highest). These differences are small, and not statistically significant. But they alert one to issues surrounding changes in technical assignment that need further study.

14. Unexpectedly, to us, the telephone interview had a number of advantages over a face-to-face setting. First, the taping procedure was much less obtrusive since, after the initial permission was received, there was no visible apparatus to attract attention to the fact that the interview was being recorded. More interestingly, even, was the fact that the lack of face-to-face contact allowed respondents to project onto the interviewer any characteristics they wished. They could tell that he was an American male, and he told them that he was himself an MIT graduate in engineering. But neither his age nor his hair style, dress, or any other visible characteristic, could differentiate him, over the phone, from the people he was talking to. He was able, therefore, to elicit full responses in all his interviews, even from respondents initially reticent, skeptical, or even hostile.

15. These dimensions emerged from discussions between both authors, after listening to the tapes and taking extensive notes. At first we tended to categorize each person by a particular meaning that engineering had for him and to view these meanings as mutually exclusive. But we soon realized that the situation is more complex, and thus hit on the notion of dimensions of meaning. These emerged, usually, from one respondent for whom a dimension was particularly salient. But once we were alerted to a dimension we realized that other respondents could also be described in terms of it. It is important to point out that none of these dimensions was anticipated by our questions. All emerged from the descriptions of day-to-day activities and from the respondents' intellectual histories. And though we have assigned them their names, they reflect the meaning of engineering to our respondents - they are emergent from the data.

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